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Rochester Institute of Technology

A Thesis Submitted to the Faculty of
The College of Imaging Arts and Sciences
in Candidacy for the Degree of
Master of Fine Arts

Digital Sketchpad:
A Portable Sketching Device

By

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November 2001

Approvals

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Signature _____

Date 11. 16. 01

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CHAPTER 1

INTRODUCTION

The Problem

Today we rely more on computers to perform our functional tasks. Many professional fields incorporate advanced applications into their respective areas. For example, widely utilized computer applications such as Photoshop and Illustrator allow people to capture concepts and ideas in the computer rather than on paper.

However, sketching using a mouse has its limitations and can be inconvenient. Users are restricted to the use of a mouse instead of a pen to sketch natural curves except with some products. Those who prefer a more comfortable hand drawing position to a mouse may find it difficult to fully express their ideas. A shortfall of art based computer applications such as Photoshop and Illustrator is that people need to install these applications on a computer that cannot be easily carried around in their palm. These limitations explain why most people today still make sketches on paper. However, the problem associated with sketches on paper is the excess consumption that leads to a waste of paper. Also, these sketches are hard to organize, and take up too much space. Bulky drawing materials such as color pencils, paint, charcoal, and pens are some of the necessary items that one normally carries in his or her bag.

Ideas on paper cannot be instantly converted into a flexible digital format, otherwise a part of the concept may be lost or forgotten by the time a user gets to a computer because the users ideas often come to them unexpectedly at any time or any place.

This thesis paper solves the problems of sketching on paper and in using existing products that are currently on the market for hand drawing. My project is a digital and portable device that has attributes such as; compact size, lightweight, and portability. These features allow for people to enjoy making their sketches at their convenience.

Analysis and Research

Shortcomings of Existing Products

Figures can be sketched on a computer using Wacom's Graphire¹ or Seiko Smart Pad² for the Palm Organizer³ applications (See Fig. 1 and Fig. 2), but these products have restrictions. The Wacom Graphire is not a portable product that can be carried around easily because a tablet has to be connected to a computer via a cable to a USB⁴ or serial port.

The Seiko Smart Pad for the Palm Organizer is portable, but it does not offer any applications to change various colors and brush styles used for the sketches. With Seiko Smart Pad, a user can only draw black lines with a pencil tool.

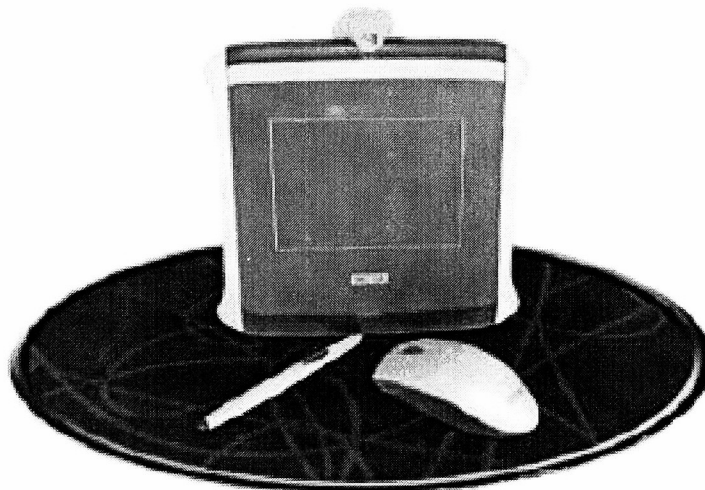


Fig. 1. Wacom Graphire

¹ Graphire, the mouse, pen and tablet set from Wacom Technology Co. <<http://www.wacom.com>>

² SmartPad, a notepad which captures handwritten notes. <<http://www.seikosmart.com/products/smartpad/>>

³ Palm INC. <http://www.palmos.com>

⁴ USB-Universal Serial Bus. A royalty-free connector standard for PCs. The USB allows up to 127 peripherals-including joysticks, scanner, printers, and keyboards is linked from a single socket, offering high speeds and improved plug-and-play facilities.

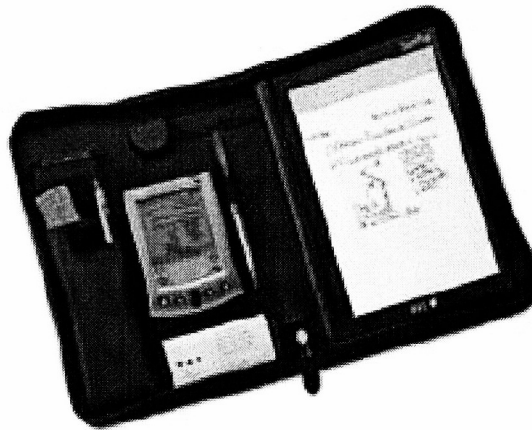


Fig. 2. Seiko SmartPad

Display Technology

A promising display technology for drawing is electronic paper⁵ display (See Fig. 3). The attributes of compact size and light-weight material are emphasized in this technology. Electronic paper is thin, flexible, portable, light as paper, and can be rolled-out. Electronic paper will soon begin to replace the displays on pagers, cellular phones and personal digital assistants. Electronic paper enables the display's paper-like qualities: easy viewing from wide angles and extraordinary brightness. The resulting sheet of electronic paper is about the thickness of thin cardboard (about 1mm). An electronic paper sheet of the size of a standard letter would cost less than \$10 to make.

⁵ For information on electronic paper go to <http://www.parc.xerox.com/epaper>. www.lucent.com

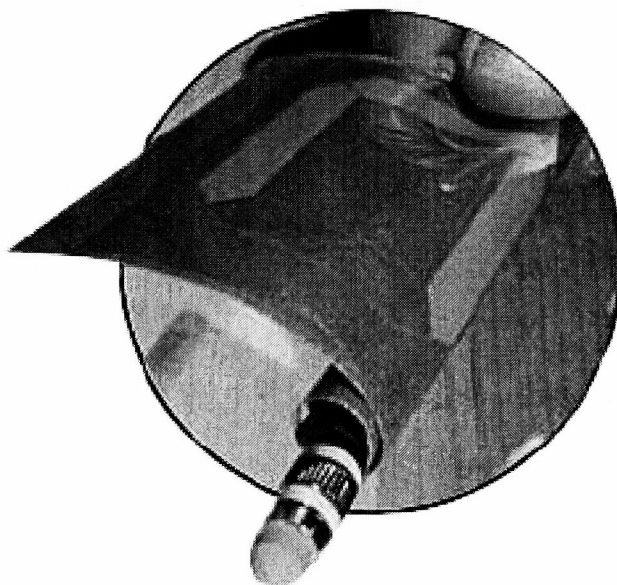


Fig. 3. Lucent Technologies Electronic paper

Ergonomic Research

According to the research for Wacom of The Global Ergonomic Technologies,⁶ a comparison of postures from pen and mouse use indicates that there is less deviation of posture from a neutral arm position during pen use than during mouse use. Studies of mouse usage have demonstrated excessive deviation from the neutral position. Pen use results in a more neutral arm position than during mouse use. Therefore, the research implies that pen use is ergonomically superior when compared to mouse use.

⁶ For information on this study go to <http://www.wacom.com/productinfo/features.html> to download this PDF Format.

CHAPTER 2

DESIGN DEVELOPMENT

Goals

The first goal of the design is to be able to take the handheld device anywhere one goes to sketch. It would be easy to take on trips, meetings or even just to lunch because of its portability. The design would be aesthetically pleasing, like Apple computers iBook and PowerBook.

The second goal is to be able to send sketches already saved in the machine to other people via Wireless Internet Access. Thereby, making it very convenient to send sketches to other people at any time and any place.

The last goal is to be able to create a user-friendly interface that users can easily sketch on. They would be able to easily transfer sketches into applications such as PhotoShop or Illustrator to enhance the sketches. Simple icons would be easy to understand and use. This device would provide different types of tools. There would be a variety of tools to sketch drawings in many colors so that people would not be intimidated by the technology and would have fun using this product.

Criteria

The criteria for the design is to define a device that will accomplish the goals. The design concepts would be developed and evaluated by the determined criteria. I determined the following criteria respective to the goals:

- User-friendly interface – The display size should be similar to that of a standard size of a paper sketchpad about 6 inches x 8 inches. The display thickness should be about 80 micrometers thick, twice the thickness of a sheet of ordinary paper. Easy transfer should be possible into applications such as PhotoShop and Illustrator to further enhance or modify sketches.

- **Portability** – The size should be small enough to take anywhere comfortably.
Housing size should be less than 4 inches (wide) x7 inches (long) x2 inches (thick).
The weight should be less than 1.5 pounds. A rechargeable alkaline battery should be placed in bottom of the housing.
- **Low cost** – The price for this device should be no more than USD \$400.
- **Ergonomics** – The device should accommodate both right-handed and left-handed users.
- **Aesthetics** – To differentiate from the current hand-held computer products today, the device should avoid the rectangular shapes and the color gray. The design should emphasize characteristics such as bright colors and a slim profile.

Concept Development

After drawing many thumbnail sketches that generated many different ideas and shapes, I chose 3 concepts to be mocked up in three-dimensional form. The 3 concepts were as follows:

1. A rollout screen - The screen can be rolled into the two sides in order to occupy less space. The use of flexible “electronic paper” makes this possible. (See Fig. 4).
2. A fold-up planner - The screen can be folded-up, collapsable into half the size (See Fig. 5).
3. A wearable device - The user could wear on a wrist. (See Fig. 6).

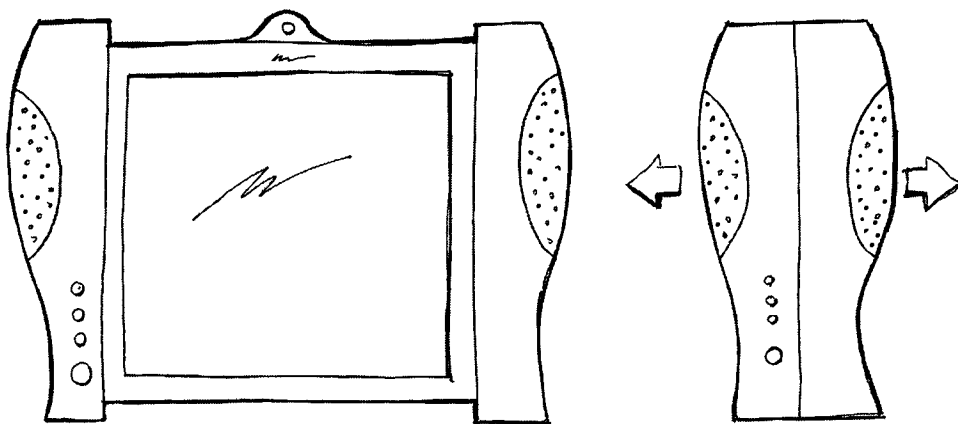


Fig. 4. "Roll-out screen" concept

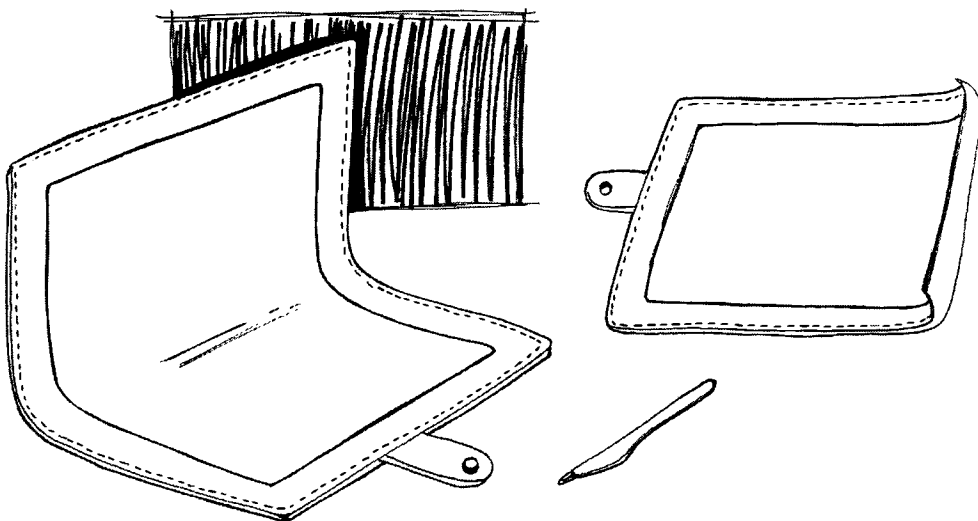


Fig. 5. "Fold-up planner" concept

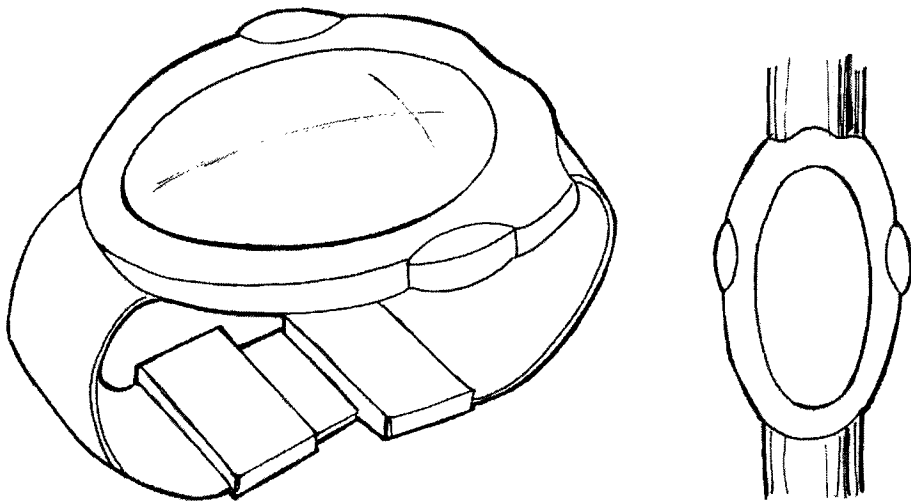















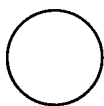


Fig. 6. "Wearable device" concept

Evaluation of Concepts

After concept development, the committee and I evaluated each concept mock-up made with blue foam. According to the evaluation, the roll-out concept satisfied the most criteria. The final concept should be able to have a compact size housing but reasonable display size. The display surface should be flat and smooth for sketching.

CONCEPT CRITERIA	CONCEPT 1 (roll-out)	CONCEPT - 2 (fold-up)	CONCEPT - 3 (wearable device)
User-friendly interface			
Portability			
Low cost			
Ergonomics			
Aesthetics			



Large satisfaction



Medium satisfaction



Small satisfaction

Table 1. Evaluation of concepts results

CHAPTER 3

FINAL DESIGN

Features

In designing the Digital Sketchpad, I determined the final form to be contoured to the shape of the palm (See Fig. 7, Fig 8 and Fig 9). When opening this device, the shape would be comfortable to the user. I also designed the telescoping panel to stabilize the flexible screen (See Fig. 10). The pannel has very thin and hard material to keep the product light in weight. To roll out this display, a traditional roller system is employed. The roller system makes it smaller in size.



Fig. 7. The contoured form gripped in one hand

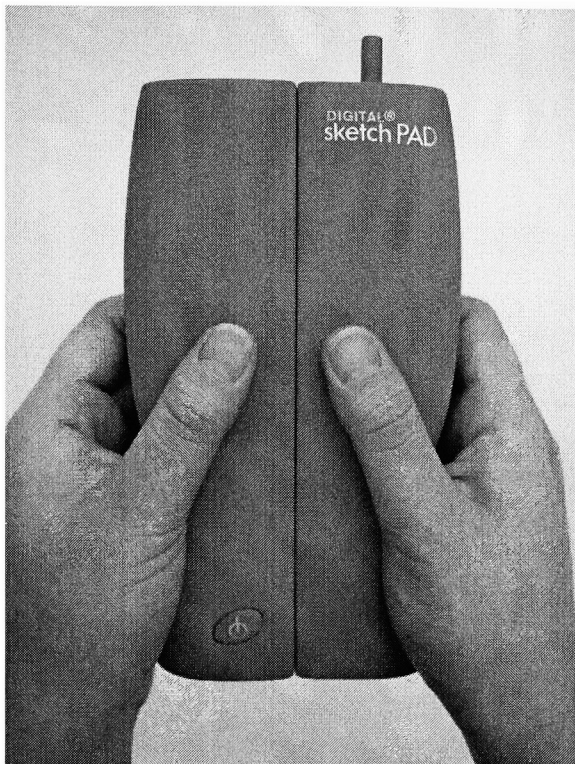


Fig. 8. The contoured form gripped with two hands

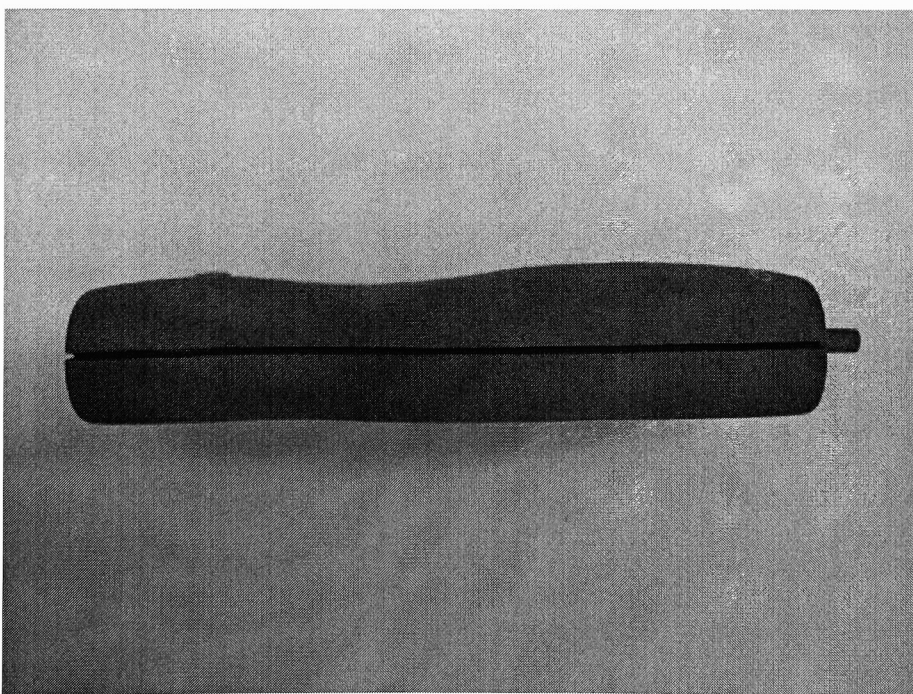


Fig. 9. The contoured form – side view

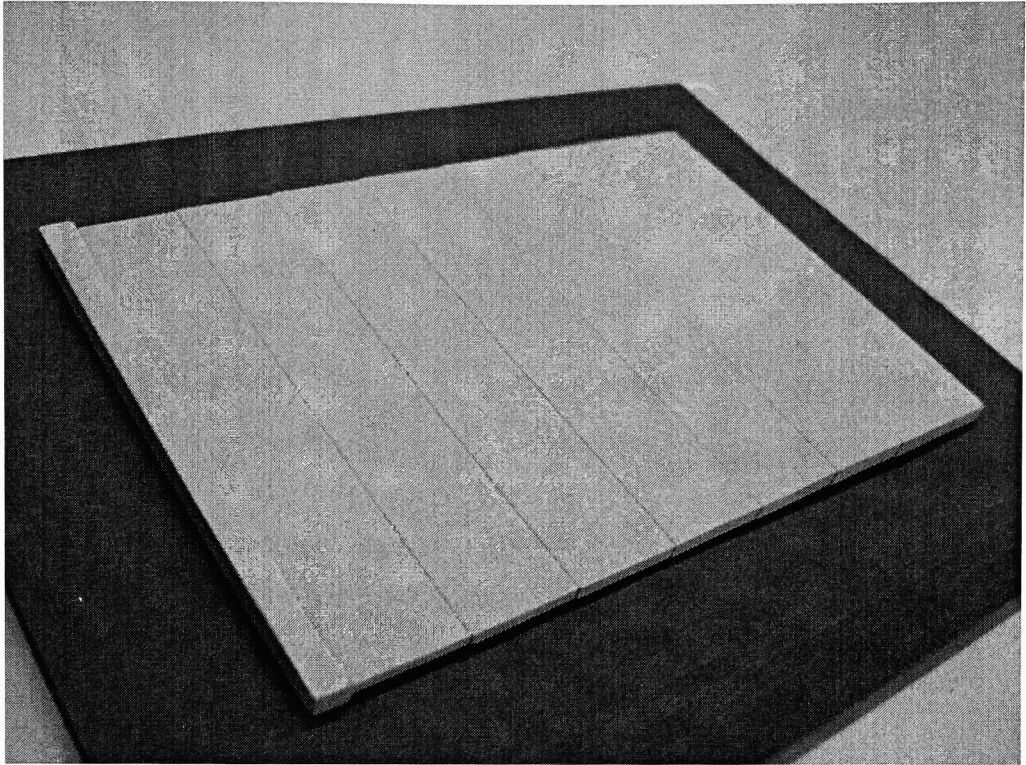


Fig. 10. The telescoping panel

The Digital Sketchpad would include several components (See Fig. 11). An input system consists of a Firewire/USB, Wireless Internet Access, and a stylus (See Fig. 12, Fig. 13 and Fig. 14). The Firewire/USB port can be connected to a computer. The Wireless Internet Access can be used as a source of instant data transfer and communication. The stylus looks like a pencil that will work with a user's particular drawing style. This pen does not need batteries or an awkward cord (See Fig. 15 and Fig. 16). The output system is the Electronic paper display (See. Fig. 17). The size of the display is 5.5 inches x 7.5 inches x 0.06 inches, which is the same as a standard paper sketchpad. The screen resolution of 150 dots per inch provides crisp readable information and clear colors. This device is powered by rechargeable battery with an AC adapter (See Fig 12). The size of the battery is less than that of two AAA batteries. The memory would be at least 32 MB of RAM available for operation.

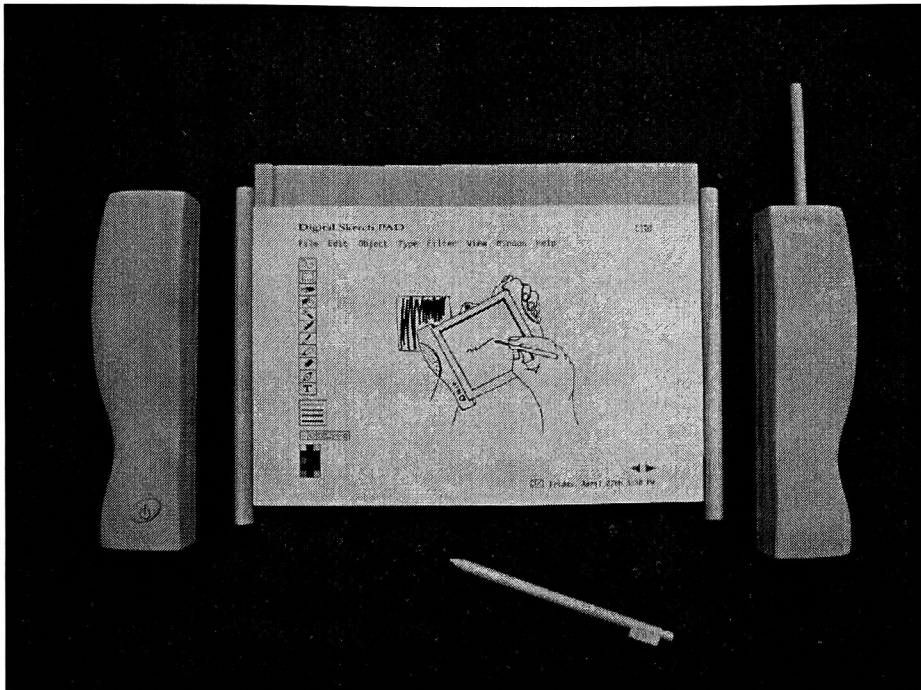


Fig. 11. Components of the Digital Sketchpad



Fig. 12. The USB, antenna, and AC adapter



Fig. 13. The power switch

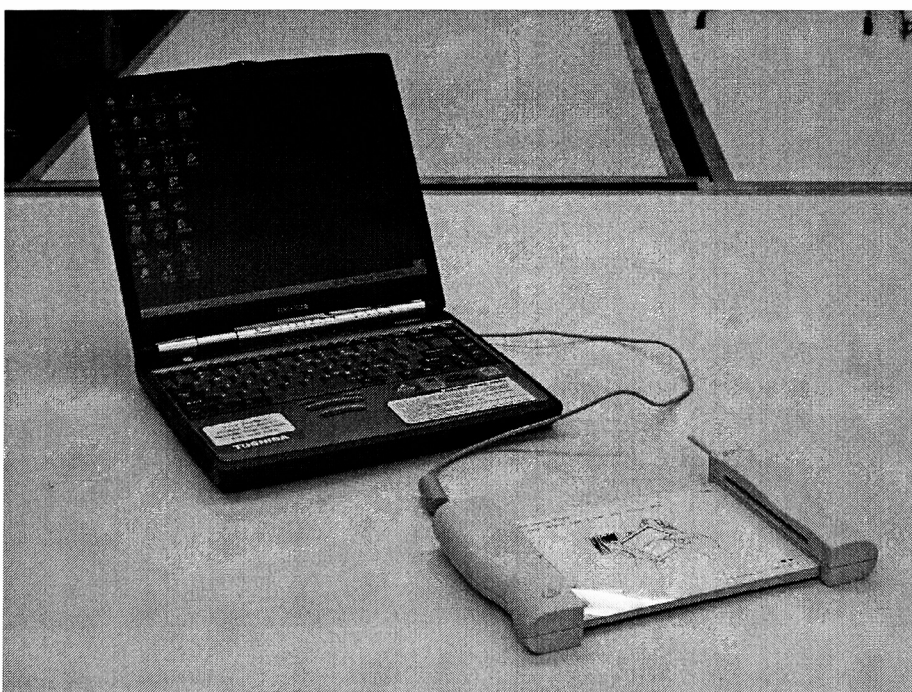


Fig. 14. The Digital Sketchpad connected to a computer

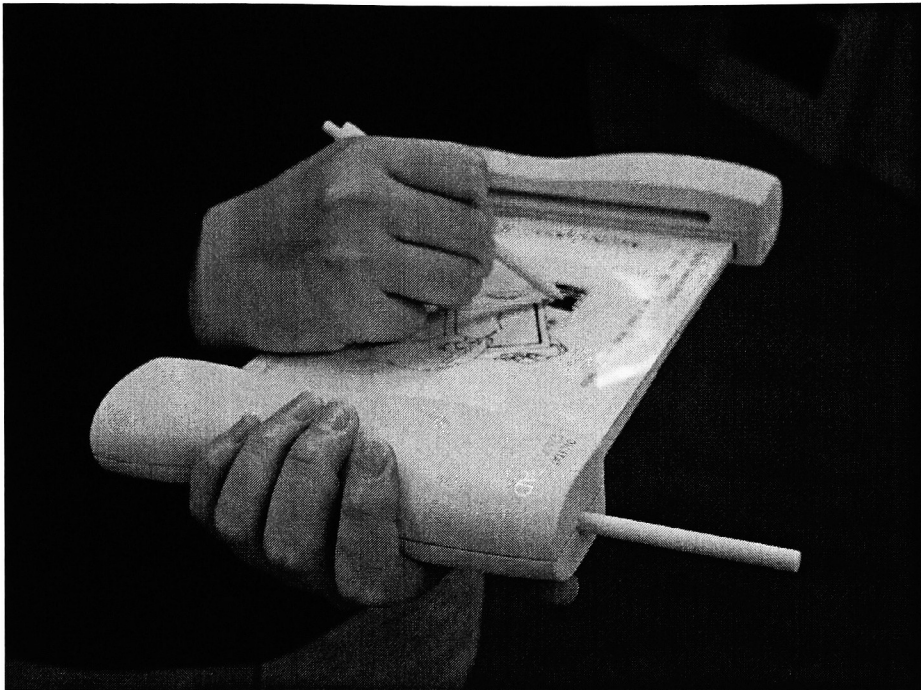


Fig. 15. The sketching position

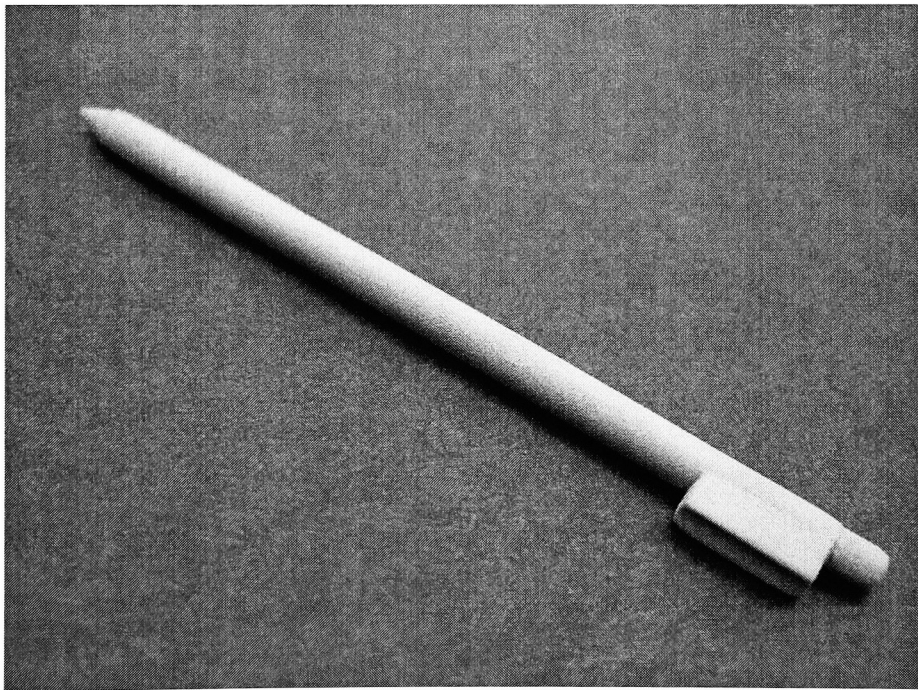


Fig. 16. The stylus

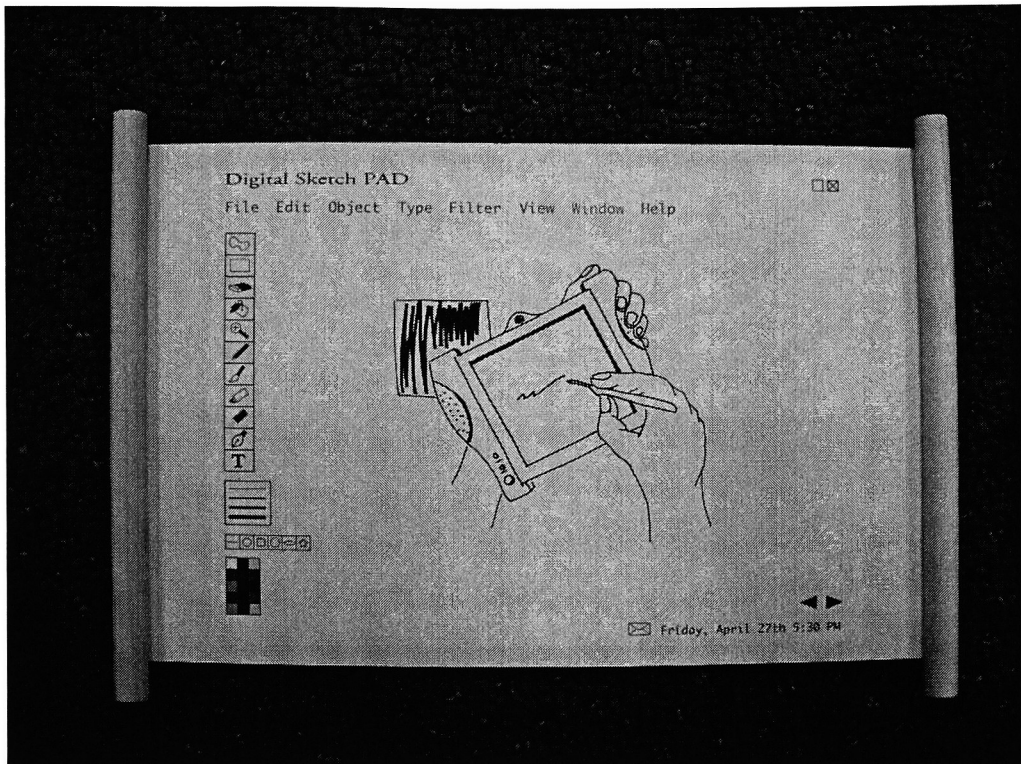


Fig. 17. The electronic paper display

Interface Design

The interface was designed with simple visual icons (See Fig. 18). The users could enhance their sketches with computer applications such as Photoshop and Illustrator. The interface was designed to be similar to Adobe Illustrator so that the users would be familiar with the interface. The active sketch area is 5 inches x 7 inches.

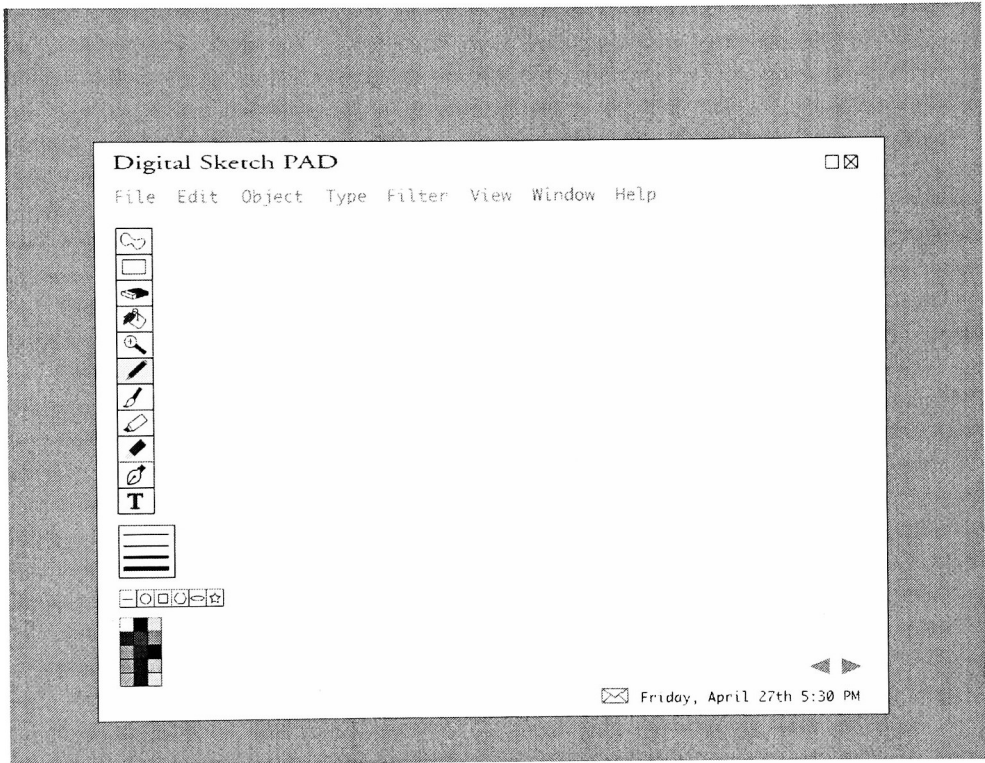


Fig. 18. The Interface design

Presentation

3D Computer Model Renderings

The virtual models of the Digital Sketchpad were constructed in the computer by using Alias/wavefront studio 9.5 (See Fig 19 and Fig.20). The models were then viewed at many different angles. 3D renderings showed the product in various materials, textures and colors.

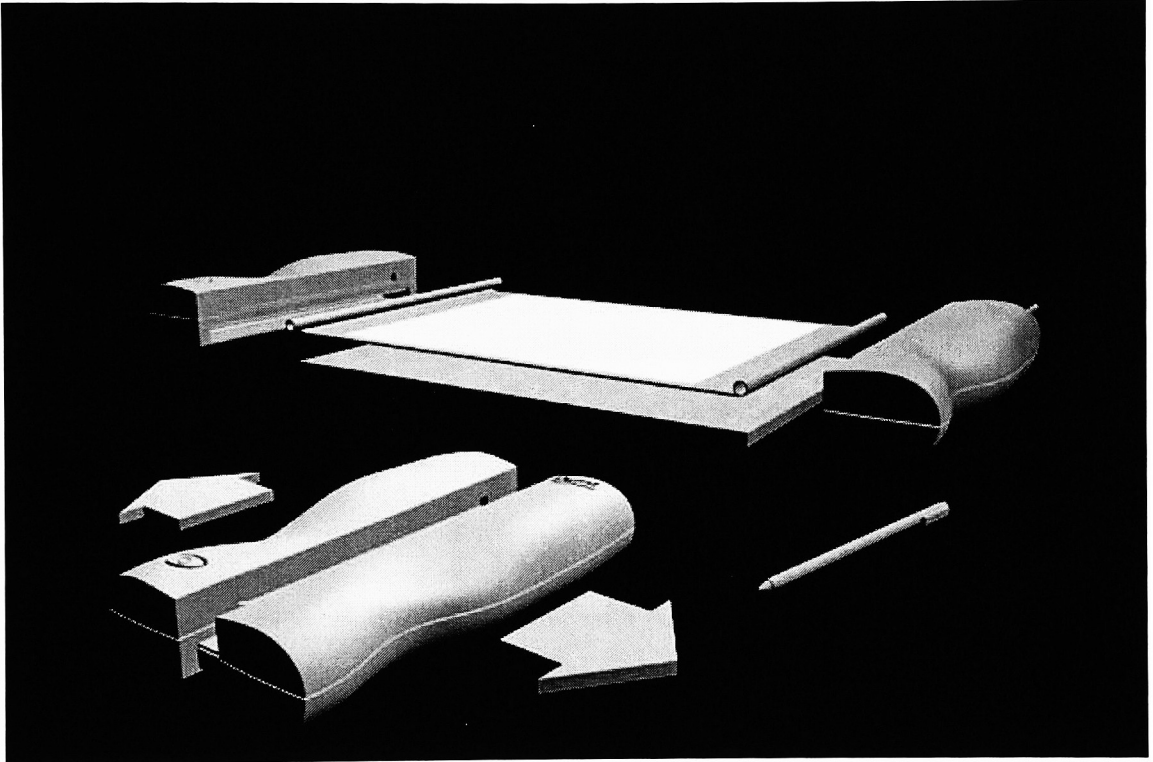


Fig. 19. 3D computer model rendering showing components

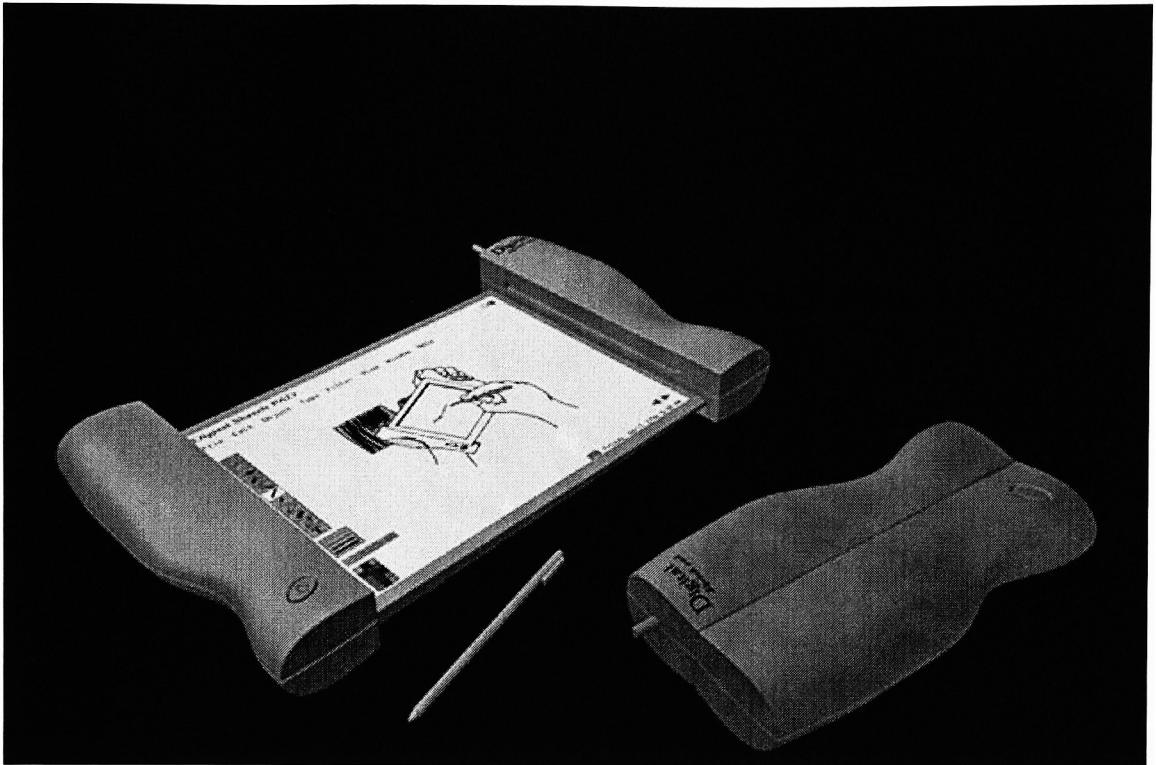


Fig. 20. 3D computer model rendering showing open and closed positions

Physical Models

After exporting the technical drawings from Alias/wavefront studio 9.5, I built several full-size physical models (See Fig. 21 and Fig. 22). Models in the closed and opened positions were made with Ren Shape 350 Board (See Fig. 23).

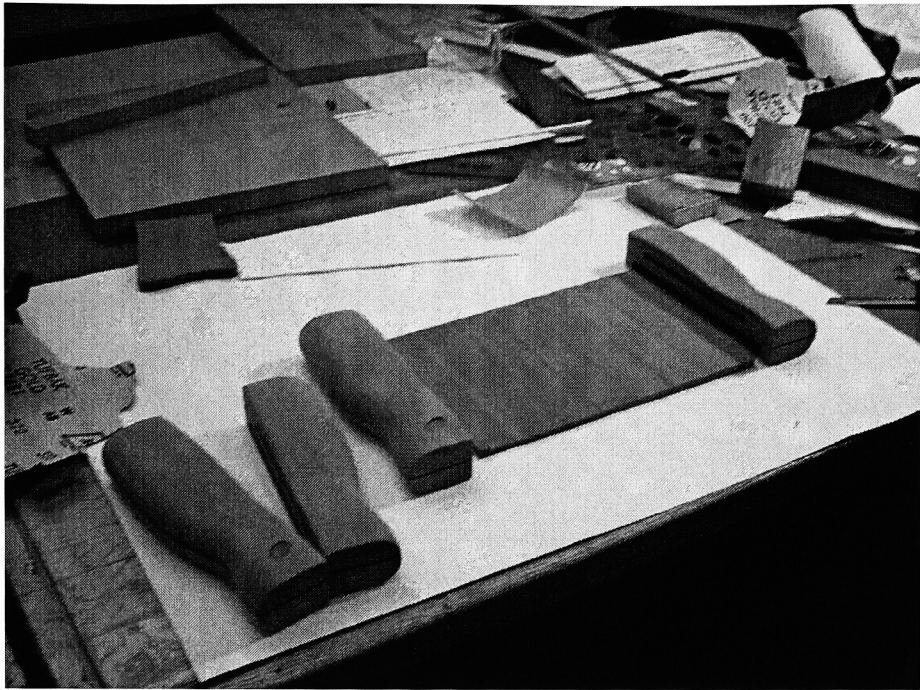


Fig. 21. The Ren Board model components



Fig. 22. The model making process

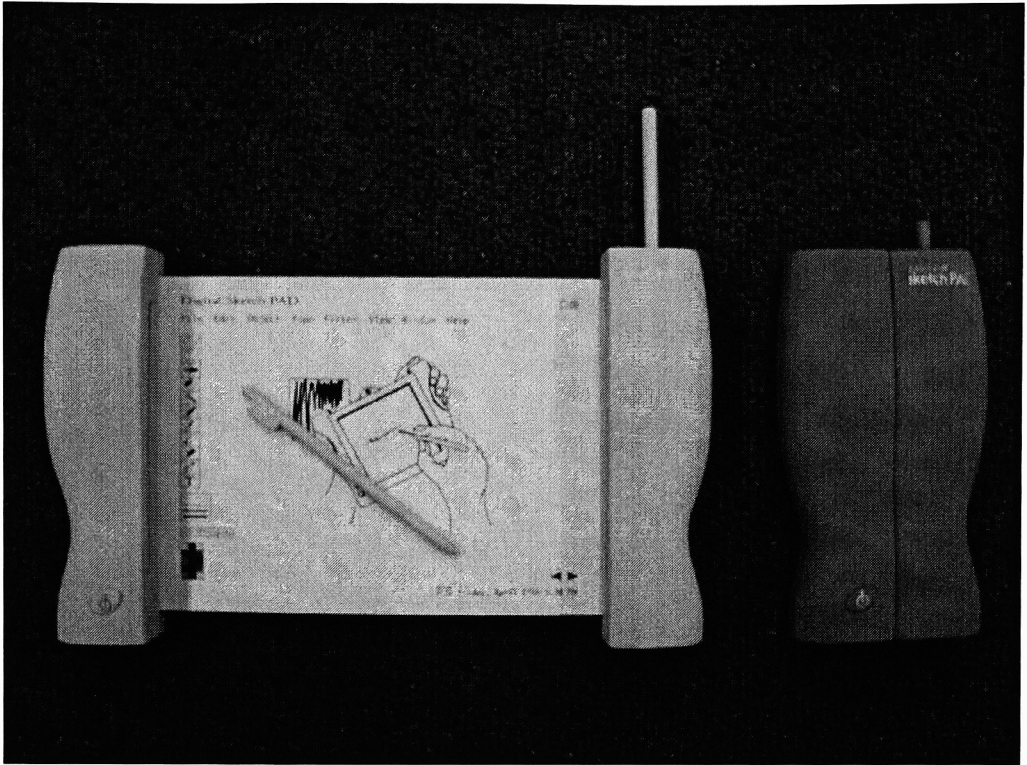


Fig. 23. The final physical models

Thesis Show Exhibition

For the gallery exhibition, posters were designed to present the features and functions. For an effective display of the design, I planned an arrangement of the model with informational posters. Also, a display stand was made of wood and transparent plastic to display the final models.

The show was held in Bevier Gallery at RIT for two weeks from April 23rd to May 9th in 2001 (See Fig. 24 and Fig.25).



Fig. 24. Thesis show exhibition overall view

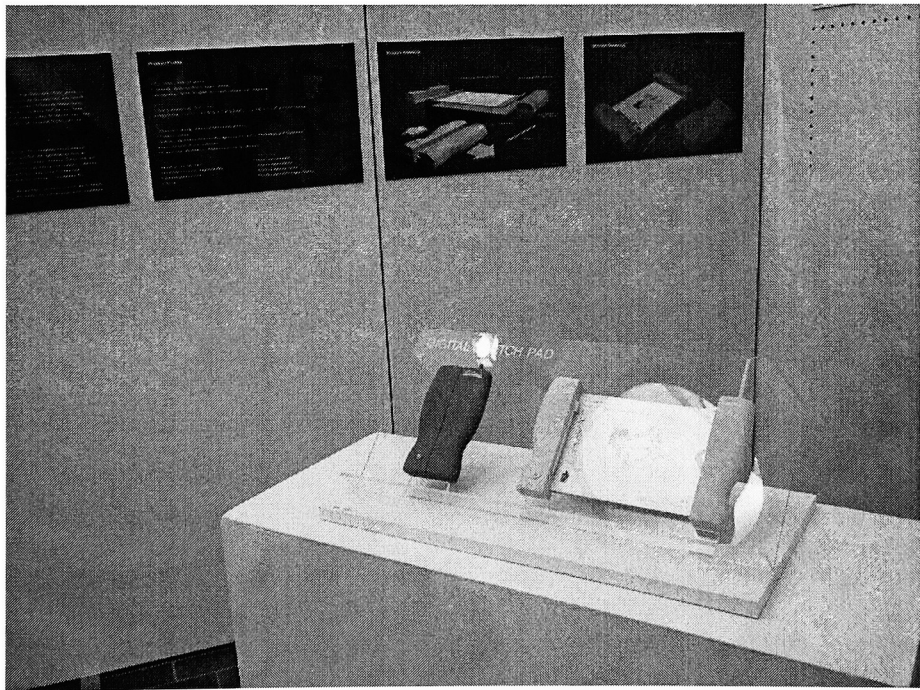


Fig. 25. Thesis show exhibition close-up view

CHAPTER 4.

EVALUATION AND CONCLUSION

Various comments were made to me at the exhibition by my thesis committee and the exhibition audience. Most gave positive feedback. I noticed a special interest in the product from children and parents. The comments can be divided into 3 categories: presentation, technology, and design.

Presentation

At the exhibition, posters and physical models were an effective means to communicate how to operate this product. The models helped the audience to understand the product more clearly.

Technology

The Digital Sketchpad was designed to incorporate existing technologies. However, “electronic paper” technology has yet to be widely marketed. This product is projected for the near future when the technology progresses in the area of electronic displays. The Digital Sketchpad would be an ideal product for the introduction of Electronic paper use.

Design

The Digital Sketchpad was formed as a humanized shape. When a user works with it, he or she will feel comfortable because of its ergonomic shape. However, the details of accessories such as the battery space and a handgrip need to be further developed. Also, more colors may be added to distinguish each component.

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